Technical Specifications
for
Track Motor Vehicle with Track Measurement, Recording and Inspection Systems

(Tender No. HN/RC/04/10)

E – 02 – 003
April 2010
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List of Attachments
Att. A  Climate and Environmental Conditions
Att. B  Loading Gauge
Att. C  INDUSI System Brochure
Att. D  Compliance Table
Definitions

"Vehicle" Self propelled track vehicle.

"Inspection System" / "Measurement System" - Measurement and recording system including the following sub-systems: geometry measurement system, rail profiles measurement system, corrugation measurement system, tunnel profiles and loading gauge profile measurement system (these systems shall be non-contact laser based and computer controlled), track elements inspection system, right of way inspection system (these systems shall be optical based and computer controlled).

"TMVM " Self propelled track vehicle with track measurement, recording and inspection systems.

“Track Recording System” as outlined in EN 13848-2:2006

List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>TMVM</td>
<td>Track motor vehicle for track measurement, recording and inspection</td>
</tr>
<tr>
<td>EN</td>
<td>European standards for products and services</td>
</tr>
<tr>
<td>ISR</td>
<td>Israel Railways</td>
</tr>
<tr>
<td>UIC</td>
<td>Union Internationale des Chemins de Fer (International Union of Railways)</td>
</tr>
<tr>
<td>DGPS</td>
<td>Differential Global Positioning System</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>RMS</td>
<td>Root mean square</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographical Information System</td>
</tr>
<tr>
<td>CWR</td>
<td>Continuous Welded Rail</td>
</tr>
<tr>
<td>PDA</td>
<td>Personal Digital Assistant</td>
</tr>
<tr>
<td>UPS</td>
<td>Uninterruptible Power Supply</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IETM</td>
<td>Interactive Electronic Technical Manual</td>
</tr>
</tbody>
</table>
1 General Requirements

The vehicle shall be self-propelled and will be used on ISR railway network for measurement, recording and analyzing the track condition. It shall include a computer controlled measurement system which shall be a non-contact laser/optical based (as defined in "definitions").

The measurement system shall include the following sub-systems:
- Track geometry measurement system;
- Rail profiles measurement system;
- Corrugation measurement system;
- Track elements inspection system;
- Right of way inspection system;
- Tunnel profiles and loading profile measurement system;

The Track Recording System shall record the measured track data on loaded conditions and produce consistent results.

1.1 Applicable Standards

1.1.1 The Track Measurement and Recording System shall comply with:
- EN13848-2:2006 - Railway applications - Track - Track geometry quality - Measurement systems - Track recording vehicles
- EN 13231-3:2006 - Railway applications - Track - Acceptance of works - Acceptance of rail grinding milling and planning work in track

Or their latest edition, unless otherwise specified.

1.1.2 The vehicle shall comply with the latest edition of:
- EN14363: 2005 Testing for the acceptance of running characteristics of railway vehicles - Testing of running behavior and stationary tests
- EN14033-1 Rail bound construction and Maintenance Machines - Technical requirements for running. The vehicle shall meet “Category 1” requirements.
- EN14033-2: 2008 Rail bound construction and maintenance machines - Technical requirements for working

1.2 General Design Requirements

1.2.1 The TMVM design shall follow the EN regulations and UIC codes for environment protection like: noise; pollution; radiation etc…

1.2.2 The TMVM shall be designed to operate under the climate and environmental conditions, dust conditions in the atmosphere, sea salt concentrations in the atmosphere according to the data provided in Attachment A.
1.2.3 The TMVM shall be designed to operate on tracks with gradient up to 35‰.

1.2.4 The TMVM shall be designed to operate on main and secondary lines with minimum curve radius of 140 meter and on shunting area with minimum curve radius of 75 meter.

1.2.5 The TMVM shall include an "INDUSI" (Inductive signal protection) system, it shall be noted that the "INDUSI" system shall not interrupt the measurement system.

1.2.6 The TMVM shall include a "dead-man" safety device to stop the vehicle in case the driver is unable to continue operating according to UIC 641 code.

1.2.7 The TMVM shall be designed to provide easy access to all the vehicle and measurement systems in order to perform maintenance tasks and running checks, inspection on and calibration of the under frame measurement equipments while on the track line and in the depot.

1.2.8 The driver cabin arrangement and visibility angles while sitting in the driver seat facing traveling direction shall comply with UIC 651 code. The TMVM crew shall have panoramic view on the track line.

1.2.9 The TMVM design shall have provisions for future installation of overhead catenary measurement system.

2 Operating Conditions

2.1 The TMVM shall have the following operating conditions:

<table>
<thead>
<tr>
<th>2.1.1</th>
<th>Track gauge</th>
<th>1435 [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1.2</td>
<td>Travel speed - self propelled</td>
<td>at least 120 [Km/h]</td>
</tr>
<tr>
<td>2.1.3</td>
<td>Travel speed - towed</td>
<td>at least 120 [km/h]</td>
</tr>
<tr>
<td>2.1.4</td>
<td>Measurement speed (*)</td>
<td>0-120 [km/h]</td>
</tr>
<tr>
<td>2.1.5</td>
<td>Max gradient</td>
<td>35 ‰</td>
</tr>
<tr>
<td>2.1.6</td>
<td>Min curve radius on shunting area</td>
<td>75 [m]</td>
</tr>
<tr>
<td>2.1.7</td>
<td>Min curve radius on main and secondary track lines</td>
<td>140 [m]</td>
</tr>
<tr>
<td>2.1.8</td>
<td>Max superelevation</td>
<td>170 [mm]</td>
</tr>
<tr>
<td>2.1.9</td>
<td>Vehicle length</td>
<td>up to 25000 [mm]</td>
</tr>
</tbody>
</table>

(*) To ensure accurate measurements in inertial type measurement other minimum speed are be offered.

2.2 Loading gauge

The TMVM shall fully comply with ISR loading gauge parameters [Attachment B].

3 Measurement System Characteristics

3.1 General

3.1.1 The system shall be designed to enable full operation by a single qualified operator.
3.1.2 An integrated control console shall be installed, it shall allow an operator to start and stop the whole Measurement and recording system with a single button or to start and stop each subsystem and application individually. The integrated control console shall show the status of each subsystem and warn the operator of subsystems malfunction. The integrated control console shall also provide single point of entry of track number, Km-Posts, line class and various track features for the whole system. The integrated control console shall also allow the operator to specify direction of motion, reconfigure the system or change exception thresholds. The integrated control console shall be synchronized with the vehicle speedometer and shall show the TMVM speed online.

3.1.3 To facilitate validation and editing of the detected features and exceptions (defects) the onboard instrumentation system shall have an Integrated Event/Exception editor console that displays all detected km-Posts, track features and defects from all onboard subsystems in real time in an integrated and distance synchronized fashion. The editor console shall allow the operator to click on any detected defect and view measured waveforms, rail profiles and track images for the defect location. The editor console shall allow the operator to reject the defect if necessary.

3.1.4 The onboard instrumentation system shall have a modular and expandable architecture allowing future addition of new measurement and data analysis subsystems.

3.1.5 The inspection system shall have an onboard DGPS location system that provides accurate (2m RMS) latitude and longitude coordinates for every measurement sample (every 250mm). The system shall provide accurate coordinates even when DGPS satellites are temporarily blocked by bridges, tall buildings, and dense foliage or when going through tunnels. The coordinates shall be used to tag start, end, and maximum value for every detected exception. The coordinates shall also be used to tag manually entered km-posts and track features. The Location system shall also be able to accurately detect km-Posts and other track features based on their coordinates in the system database. The system shall have the ability to transfer position coordinates to a Geographical Information System (GIS) database.

3.1.6 The inspection system shall have an onboard database and a flexible report generator that allows the operator to specify the content of the desired report. The operator shall be able to specify a segment of track of interest (for example, subdivision ABC, from km-Post xx to km-Post yy), type of data of interest (for example, geometry, rail wear, ride quality, or all), desired severity of defects (for example, only high level defects or all defects), and other query parameters as needed. The operator shall be able to print those reports.

The bidder shall provide with his proposal a specification and the required content of the database that ISR will have to prepare to load the system with the base database.

The Bidder shall attach to his proposal reports samples.
3.1.7 The measurement system shall be designed to ensure data collection and processing as stated in this technical specification regardless of weather, light, dust or any other ambient conditions at the same efficiency in both directions.

3.1.8 The measurement system components mounted underneath the frame shall be waterproof and sealed to avoid dust, mud, grease and dump penetration. Optical systems shall not be influenced by ambient light (reflection from sun light), and shall fully operate during daylight and in the dark. The laser beam accurate work shall be ensured while operating in desert zone. The bidder shall provide with his proposal technical specifications of all the components comprising the measurement system.

3.1.9 The system shall be maintenance free during the measurement period as to provide reliable measurement in extreme environmental conditions (rain, dust, mud, fog, etc.).

3.1.10 The system shall be protected from stones or other objects present along track.

3.1.11 Axle counter operation shall not be interrupted by any means while operating the TMVM.

3.1.12 The system shall be capable to operate between the following speeds:

- Minimum Speed – please specify;
- Maximum Speed – please specify.

3.1.13 The system shall enable automatic detection and reporting of the following curve parameters:

- Start of horizontal transition curve;
- End of horizontal transition curve;
- Length of horizontal transition curve;
- Start of circular curve;
- End of circular curve;
- Superelevation;
- Start of vertical transition curve;
- End of vertical transition curve;
- Length of vertical transition curve;
- Start of vertical curve;
- End of vertical curve;
- Direction of the curve.

The system shall report the deviation of the curve parameters from the curve parameters in the database. (Sample reports shall be provided with the proposal).
3.1.14 20 licensed copies of offline viewing application software that allows track engineers and inspectors to view the results of the TMVM on their office PCs or on field laptops shall be supplied. At minimum, the viewer shall have the following functionality:

- The ability to display measured geometry, rail cant, and rail wear waveforms in an integrated and synchronized fashion.
- The ability to display detected track geometry, rail cant, and rail wear exception list in an integrated and synchronized fashion.
- The ability to display detected curves list including calculated curve parameters.
- The ability to click on any exception or curve and view waveforms and cross sectional rail profiles for this location.
- The ability to scroll waveforms and exception lists back and forward, change vertical and horizontal scales, select and configure displayed channels.
- The ability to overlay new run results with previous runs even if the previous run was made in an opposite direction.
- Viewer description, specification and screen printout samples shall be provided with the proposal.

3.1.15 20 Personal Digital Assistant (PDA) devices (known also as palmtop computer) for track inspectors to assist in finding and verifying defects in the field shall be supplied. The devices shall be able to load defects detected by the Vehicle and display type, value and location of defect in the field. The devices shall have and integrated DGPS and shall inform inspectors on their distance from the defect and when they reach the location of the defect. The inspectors shall be able to put notes and change parameters for the defect or enter a new defect.

Personal Digital Assistant (PDA) devices description, specification and screen printout samples shall be provided with the proposal.

3.1.16 The system shall include state of the art hardware and software necessary for the complete operation control and processing data.

The system shall provide full synchronization of all system data sources including DGPS system.

3.1.17 To prevent the interruption of the measurements and the loss of recorded data in case the measurement hardware power supply fails, an adequate uninterruptible power supply (UPS) shall be provided.

3.1.18 The electrical and computerized equipment shall be of industrial type suitable to operate in the vibration and temperature conditions existing in the TMVM.

3.1.19 The ISR rail system current size is 1,000km with plans to be increased to 2,000km within the next decade. The system shall have the potential for the increased capacity.
Also an increase in the number of input signals as well as of the number of calculations made shall be foreseen in the system design.

3.1.20 Procedures of signal and data processing as of visualization and output data shall comply with EN 13848-1 and EN 13848-2 standards unless specified otherwise. Procedures shall be part of bidder’s proposal.

The system shall enable adjustments of data output according ISR choice.

3.1.21 All measurements shall be sampled at a sampling rate of 15 samples per second.

3.1.22 The computers shall be operated by Microsoft corporation state of the art Operating System (Windows XP or Windows 7). All the application systems software shall be suited to work properly under the operation system.

3.1.23 For backup storage and offline use the recorded measurements data shall be transferable using removable storage media (DVD and USB ports) and a network or radio link with an industry standard.

3.2 Measurement Parameters

3.2.1 The TMVM shall be designed to enable measurement and recording track geometry on both rails simultaneously (on Continuous welded rail (CWR), fish plated and rail joints).

3.2.2 The TMVM shall be designed to enable measurement and recording data on track with rails types used in ISR network: U50; UIC54 (UIC54 E1); UIC60 (UIC60 E1) at rail inclinations of 1:20 and 1:30.

3.2.3 The TMVM shall be designed to enable measurement and recording data on switches used in ISR network type: 1/8; 1/9; 1/12; 1/20; scissor crossover; double slip as well as on CWR, fish plated rail joints and rail expansion joints.

3.3 Geometry Measurement System

3.3.1 General

The Geometry measurement system shall measure at minimum the following parameters:

- Track gauge;
- Longitudinal level of left and right rail simultaneously;
- Alignment of left and right rail simultaneously;
- Cross level\Superelevation;
- Curvature and radius;
- Slope\Gradient of the rail (curve in the vertical plane of the rail);
- Position and travel distance;
- Twist.
3.3.2 The Geometry measurement system data could be printed out on A3 size paper laser color printer, the printing data shall be continuously through the entire measurement procedure.

The printing data scale shall be 1:1000.

The measurement system shall have at least the following scales:

- Longitudinal level: 1:1; 1:2; 1:3
- Track Gauge: 1:1; 1:2
- Twist: 1:1
- Superelevation: 1:2; 1:5
- Versine: 1:1; 1:2.5; 1:5; 1:10

It shall be possible to mark various grid formats on the printed page. Provide samples.

3.3.3 Track gauge

3.3.3.1 Measurement requirements for track gauge

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>≤0.5[mm]</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>±1[mm]</td>
</tr>
<tr>
<td>Reproducibility 95%</td>
<td>±1[mm]</td>
</tr>
<tr>
<td>Range of measurement</td>
<td>1420 - 1485 [mm]</td>
</tr>
</tbody>
</table>

3.3.3.2 Track gauge measurement shall be recorded as a consecutive set of readings in digital form and shall also be presented graphically.

3.3.3.3 Track gauge measurement outputs shall be at minimum prescribed as follow: (provide sample output)

- The identification of individual defects which exceed prescribed threshold.
- The measured track gauge.
- The difference between the measured track gauge and the nominal track gauge.
- The mean track gauge over a specified distance.
- The variation of track gauge over a specified distance.

3.3.4 Longitudinal level

3.3.4.1 Measurement requirements for longitudinal level:

3.3.4.2 Longitudinal level measurements shall be made following EN 13848-2 Para. B.2, with an inertial measurement system or with a chord measurement system.

<table>
<thead>
<tr>
<th>Wavelength ranges [m]</th>
<th>1&lt;λ&lt;25</th>
<th>25&lt;λ&lt;70</th>
<th>70&lt;λ&lt;150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>≤0.5[mm]</td>
<td>≤0.5[mm]</td>
<td>≤0.5[mm]</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>±1[mm]</td>
<td>±3[mm]</td>
<td>±5[mm]</td>
</tr>
<tr>
<td>Reproducibility 95%</td>
<td>±0.8[mm]</td>
<td>±2[mm]</td>
<td>±5[mm]</td>
</tr>
</tbody>
</table>
3.3.4.3 Measurements shall be recorded as a consecutive set of readings in digital form and shall also be presented graphically.

3.3.4.4 Longitudinal level measurement outputs shall be at minimum prescribed as follow: (provide sample report)

- Isolated defects that exceed a prescribed threshold;
- A standard deviation over a defined length (every 200 meters).

3.3.5 Alignment

3.3.5.1 Measurement requirements for alignment:

<table>
<thead>
<tr>
<th>Wavelength ranges [m]</th>
<th>1&lt;λ&lt;25</th>
<th>25&lt;λ&lt;70</th>
<th>70&lt;λ&lt;200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>≤0.5[mm]</td>
<td>≤0.5[mm]</td>
<td>≤0.5[mm]</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>±1.5[mm]</td>
<td>±4[mm]</td>
<td>±10[mm]</td>
</tr>
<tr>
<td>Reproducibility 95%</td>
<td>±1.1[mm]</td>
<td>±3[mm]</td>
<td>±7[mm]</td>
</tr>
<tr>
<td>Range of measurement</td>
<td>±50[mm]</td>
<td>±100[mm]</td>
<td>±500[mm]</td>
</tr>
</tbody>
</table>

3.3.5.2 Alignment measurements shall be made following EN 13848-2 Paragraph B.2 with an inertial measurement system or with a chord measurement system.

3.3.5.3 Measurements shall be recorded as a consecutive set of readings in digital form and shall also be presented graphically.

3.3.5.4 Alignment measurement outputs shall be at minimum prescribed as follow: (provide sample report)

- Isolated defects that exceed a prescribed threshold;
- A standard deviation over a defined length (every 200 meters).

3.3.6 Cross level/superelevation measurement

3.3.6.1 Measurement requirements for cross level/superelevation

<table>
<thead>
<tr>
<th>Resolution</th>
<th>≤0.5[mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertainty</td>
<td>±5[mm]</td>
</tr>
<tr>
<td>Reproducibility 95%</td>
<td>±2.5[mm]</td>
</tr>
<tr>
<td>Range of measurement</td>
<td>±225[mm]</td>
</tr>
</tbody>
</table>

3.3.6.2 Measurements shall be recorded as a consecutive set of readings in digital form and shall also be presented graphically.

3.3.6.3 Cross level/superelevation measurement outputs shall be at minimum prescribed by its absolute value. (Provide sample report)

3.3.7 Twist

3.3.7.1 Measurement requirements for twist

<table>
<thead>
<tr>
<th>Resolution</th>
<th>±0.5[mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base length /</td>
<td>/ ≤ 5.5[m]</td>
</tr>
<tr>
<td>Uncertainty, direct measurement</td>
<td>±1/ / [%]</td>
</tr>
<tr>
<td>Uncertainly, indirect measurement</td>
<td>±1.5/ / [%]</td>
</tr>
</tbody>
</table>
### Reproducibility

<table>
<thead>
<tr>
<th>Description</th>
<th>Direct 95%</th>
<th>Indirect 95%</th>
<th>Range of measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reproducibility direct</td>
<td>±1/ [‰]</td>
<td>±1.5/ [‰]</td>
<td>15 [‰]</td>
</tr>
<tr>
<td>Reproducibility indirect</td>
<td>±1/ [‰]</td>
<td>±3/ [‰]</td>
<td></td>
</tr>
<tr>
<td>Range of measurement</td>
<td>15 [‰]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Twist Measurements

3.3.7.2 Twist measurements shall either be taken simultaneously at a fixed distance or be computed from consecutive measurements of cross level.

3.3.7.3 Measurements shall be recorded as a consecutive set of readings in digital form and shall also be presented graphically.

3.3.7.4 Twist measurement outputs shall be at minimum prescribed as follow:
- Isolated defects that exceed a prescribed threshold;
- A standard deviation over a defined length (every 200 meters).

### Rail Profiles Measurement System

3.4.1 The TMVM shall include rail profiles measurement system (simultaneously on each rail) as part of the measurement system.

3.4.1.1 Measurement requirements for rail profile

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>≤0.5 [mm]</td>
</tr>
<tr>
<td>Sampling rate</td>
<td>15 measurements/sec.</td>
</tr>
<tr>
<td>Sampling step</td>
<td>~2 [m]</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Up to ±0.127 [mm]</td>
</tr>
</tbody>
</table>

3.4.2 The profile measurement system output shall be at minimum prescribed:
- Rail type;
- Rail profile;
- Vertical wear;
- Horizontal wear;
- Rail inclination;
- Metal / lip flow;
- Gauge profile.

### Acceleration Measurement

3.5.1 The TMVM shall be designed to measure acceleration to be used in conjunction with main parameter of the geometrical measurements.

3.5.2 The following accelerations shall be measured:

3.5.2.1 Vertical axle box acceleration – for the detection of rail surface defects and isolated geometrical defects. (C1, according EN13848-1:2003+A1:2008, Annex A).

3.5.2.3. Transverse and vertical Vehicle body acceleration – for the detection of defects that have influence on comfort. (C3, according EN13848-1:2003+A1:2008, Annex A).

3.5.3. The frequency range shall be as follow:

3.5.3.1. C1 - Axle box acceleration 0-250 Hz.
3.5.3.2. C2 - Bogie acceleration 0-250 Hz.
3.5.3.3. C3 - Vehicle body acceleration 0-100 Hz.

3.5.4. The measurement range shall be as follow:

3.5.4.1. C1 - Axle box acceleration ±1000 m/s².
3.5.4.2. C2 - Bogie acceleration ±50 m/s².
3.5.4.3. C3 - Vehicle body acceleration ±10 m/s².

3.5.5. The sampling frequency shall be at least 2.5 times the cut-off frequency applied to the signal.

3.5.6. The measurement speed shall be as follow:

3.5.6.1. C1 – Axle box acceleration measurement speed shall be greater than 50 km/h.
3.5.6.2. C2 and C3 – bogie and Vehicle body acceleration measurement shall be made at the operating speed for the line within tolerance of ±10%.

3.5.7. Analyzing of Isolated defects shall be represented by the amplitude from zero to the peak value.

3.5.8. Measurement results shall be presented in graphical form. A digital recording of raw data shall also be made to enable further analysis of measurements.
   The measurement results of C1- Axle acceleration shall be presented as a standard deviation over a given duration for specified wavelength range.
   The measurement results of C2 and C3 – Bogie and Vehicle body acceleration shall be presented as isolated defects that exceed a prescribed threshold.

3.6 Rail Corrugation Measurement System

3.6.1. The Rail corrugation system shall include corrugation measurement system based on short chord with non contact laser sensors tracking the top of each rail.

3.6.2. The Rail corrugation system shall be able to measure short deviations in rail surface with wavelength from 10[mm] to 1000[mm] according to the EN 13231-3 standard.

3.6.3. The Rail corrugation system shall report for each rail the corrugation amplitude on four ranges (10-30 mm; 30-100 mm; 100-300 mm; 300-1000 mm) of wavelengths simultaneously.

3.6.4. The Rail corrugation system shall report any exceptions from predefined corrugation limits. Predefined corrugation limits shall be adjustable. (Provide sample report)
3.7  Track Elements Inspection System

3.7.1  The track elements inspection system shall be equipped with 2 optical systems (video cameras) for track element digital recording in High Definition quality simultaneously on both rails to enable inspection of the track components (rails, sleepers, fastening devices, fish plates, screws, etc.) and head rails defects operating efficiently day and night, and recording the data on digital storage media for future display at least 350 [km] by each camera.

3.7.2  The digital photo shall be with digital zoom of at least X1000 and optical zoom of at least X50. The optical system shall include picture stabilizer.

3.7.3  The 2 digital optical systems for the track element inspection system and the digital optical system for right of way inspection shall be output simultaneously on the same split screen in the TMVM and shall be saved together on the same computer under the same file name.

3.7.4  The high resolution of the optical system allow the operator to see defects on rail head and the condition of the track fastening elements, fish plates, rail fasteners, screws and sleepers.

3.7.5  The optical system shall include scale measurement software to enable accurate measurement of defects sizes and measurement of guard rail gauge check and frog rail gap when going through switches.

In addition the system shall measure the distance between the outside rail and the frog (8 cm away from the frog tip) and the gap between the outside rail and the check rail at that point. These measurements shall be report on together with the size of the difference between these measurements.

3.7.6  The system shall be connected and synchronized with the DGPS system and enable position display.

3.7.7  The bidder shall provide with the offer a demo of video data recorded on track.

3.8  Right of Way Inspection System

3.8.1  The track elements inspection system shall be equipped with an optical system (video cameras) for right of way inspection and recording to enable visually inspection of the transition area (weed control, fences, drainage ditches, etc.) operating efficiently day and night, and recording in High Definition quality the data on digital storage media for future display at least 350 [km].

3.8.2  The digital photo shall be with digital zoom of at least X1000 and optical zoom of at least X50. The optical system shall include picture stabilizer.

3.8.3  The onboard instrumentation shall include a fully digital Right of Way Video Imaging System that captures high resolution digital images of a right of way at least every 10m. The images shall be synchronized with the rest of the data and shall be accessible in real time by the system operator to view locations of the detected exceptions.
3.8.4 System shall be equipped with video systems:
3.8.5 Driver's view video system on both directions (2 cameras) in order to enable inspection of the track and the surrounding area.
3.8.6 The system shall enable video inspection by the operator.
3.8.7 The system shall be connected and synchronized with the DGPS system and enable position display.

The bidder shall provide with the offer a demo of video data recorded on track.
3.8.8 The 2 digital optical systems for track elements inspection and the digital optical system for right of way inspection shall be output simultaneously on the same split screen in the TMVM, and shall be saved together on the same computer under the same file name.
3.8.9 The system shall enable real time data display on monitors and data storage for later display processing and printing of 10,000 [km] of track. The software shall enable data analyzing regarding previous data collections.

3.9 Tunnel Profiles and Loading Gauge Profile measurement System
3.9.1 The proposal for the TMVM shall include tunnel profiles inspection and visualization non-contact laser based and computer controlled system.
3.9.2 Measurement requirements for tunnel profiles measurement system

<table>
<thead>
<tr>
<th>Resolution</th>
<th>≤2 [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling step</td>
<td>300 [mm]</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Up to ± 4[mm]</td>
</tr>
</tbody>
</table>

3.10 Other Requirements
3.10.1 The TMVM design shall consider future installation of overhead catenary measurement and inspection system.

4 Vehicle Construction
4.1 Frame
The frames shall be made from standard rolled steel.

The following are provided on the frames:

- 4 lifting hooks for handling;
- 4 guard-irons;
- Side steps.

4.1.1 Coupling and Buffers
Each headstock shall be fitted with UIC type coupling system and buffers, namely:

- 1 central Draw Gear to UIC 520 with an elastic draw system;
- 1 Draw Hook to UIC 520 OR with a breaking force of 1,000KN;
4.2 Wheel-sets and Suspension

The axles shall be of unalloyed carbon steel in accordance with UIC 811 and shall meet the requirements of EN 13104. The wheels shall comply with EN 13979-1 standard and shall be 920mm diameter at the point of traction. The wheel shall be made of mono-block steel, category R9 – UIC 812-3. Rupture resistance shall be: \( R = 90/105 \text{DaN/mm}^2 \).

Axle boxes shall have roller bearings. They are fitted with 12% manganese steel wear slides as well as axle guards.

Leaf springs with shackles at both ends shall provide the suspension.

Hydraulic shock absorber on each axle box shall be provided.

4.3 Braking System

The braking device shall comply with UIC 540 standard. Braking power shall be calculated according to UIC code 544-1.

The brake system shall comprise of:

- 1 direct and automatic compressed air brake, acting on the four wheels of the vehicle through cast iron shoes
- 1 emergency compressed air brake operated by a valve near an access door acting on the same linkage as the direct brake
- 1 screw type hand brake acting on 1 axle

The compressed air system shall provide the necessary pressure for integration the vehicle in train formation according to UIC code 540.

The compressed air system shall assure the pressure for full operation of braking system and other auxiliary needs.

The system shall include an air dryer, water separator and a full flow replaceable filter elements.

5 Propelling System

5.1 Engine

The vehicle shall be powered by at least 400 [hp] liquid cooled diesel engines.

The engine shall have EURO 4 rating according to the European Emission Standard requirements (provide technical specifications).

The vehicle shall enable direct access to the engine without entering the cabin.

5.2 Engine Cowling
A cowling shall protect the drive, engine and transmission lines. This cowling shall have side access doors. These doors shall be of openwork design for cooling the driveline.

5.3 Cooling System
The cooling system shall enable continuous safe operation of the engine at the ambient temperature given in paragraph 2.3. The loss in heat transfer efficiency due to the hot and dusty environment shall be taken into consideration.

5.4 Fuel System
The fuel system tank capacity shall enable continuous operating of at least 1000 [km]. (Specify tank volume)
Fuel system shall be provided with a sediment bowl and a full flow replaceable element filter. (Provide brochure)
Refueling points shall be provided on both sides of the vehicle.

5.5 Air Intake
Air intake shall include a double filter system. (Provide brochure)
- 1st stage: cyclonic - filter self cleaning;
- 2nd stage: dry type - replaceable filter element.

5.6 Engine Protection System
Engine protection system shall protect the engine against:
- High coolant temperature;
- Low coolant level;
- Low oil pressure;
- High oil temperature.

5.7 Transmission
A POWER – SHIFT type transmission shall be provided that will allow changing of gears under load (provide technical specifications).
The Hydro-mechanical transmission shall consist of:
- Torque converter directly flanged to the rear face of the engine.
- Transmission with 4 forward and 4 reverse ratios, 4 gears for each direction of travel.
The transmission shall be located between the 2 axles and its two opposite outputs shall be each connected to the axle by two universal joints.
A multiple discs clutch for changing gear shall be provided which shall be hydraulically operated and require no adjustment.
Operating control shall be provided by:
1 pressure gauge and
1 red warning indicator in the event of low pressure.

Two universal joints and two axle gearboxes shall provide axle transmission.

The system shall enable traveling in train formation.

The system shall enable transmission system disconnecting.

6 Hydraulic System
The hydraulic system shall be designed as to provide efficient operation in the ambient conditions given in paragraph 2.3.

The Hydraulic system shall be equipped with oil cooling system.

7 Electrical System
7.1 Applicable Standards
7.1.1 EN 50121-3-1:2006 Railway Applications - Electromagnetic Compatibility - Part 3-1: Rolling Stock - Train and Complete Vehicle
7.1.2 EN 50121-3-2:2006 Railway Applications - Electromagnetic Compatibility - Part 3-2: Rolling Stock – Apparatus
7.1.4 EN 50155:2007 Railway Applications - Electronic Equipment Used on Rolling Stock
7.1.5 EN 50215:2002 Railway Applications - Testing of Rolling Stock after Completion of Construction and Before Entry into Service
7.1.6 EN 61373:2003 Railway Applications - Rolling Stock Equipment - Shock and Vibration Tests
7.1.7 IEC 61991 Ed. 1.0 Railway applications - Rolling stock - Protective provisions against electrical hazards

7.2 Electrical Power Supply
An engine mounted generator shall supply stabilized electrical power, regardless of engine speed, to energize the measurement equipment and all other vehicle systems. The vehicle shall have 50% spare capacity.

The vehicle batteries shall be maintenance free type. The batteries capacity shall not be less than 200 [Ah].

The batteries shall not produce emission of toxic gasses.

The vehicle shall be equipped with an auxiliary power generator to enable full operation of the inspection system when the main generator is shut off.

The vehicle shall be equipped to receive power supply from a local mains system or another source of energy at 220 V or 380 V, 50 Hz. System shall meet the requirements of UIC Code 554-1.
All electrical components shall meet EN and IEC safety requirements. All electrical cables shall meet the requirements of UIC 895.

8 Cabins

8.1 Design guidelines

The cabins shall be designed and equipped following the guidelines in UIC 651 with additional space for the measurement and analyzing systems equipment and control panels. The following specific paragraphs from the UIC 651 code shall apply: 2.2.2.3; 2.7.5.2; 2.8.3; 2.9.4.1; 2.11.1; 2.11.2.

8.2 Air-conditioning System

All the cabins shall be fully air-conditioned providing cooling, heating and ventilation from the same apparatus. The system shall operate efficiently in ambient conditions given in paragraph 2.3 with maximum number of operators when all the systems in the cabin are in operation. The system shall meet the requirements of EN 14813-1:2007 “Railway applications - Air conditioning for driving cabs - Part 1: Comfort parameters” and UIC 651, paragraph 2.9. Heat generated by the measurement equipment shall be taken in the calculation of the air-conditioning unit.

All measurement equipment components shall be installed in the temperature controlled area.

8.3 Driver Visibility

The driver visibility sitting in the driver seat facing traveling direction shall fully comply with UIC 651 paragraph 3.

8.4 Cabin Equipment

The TMVM cabin shall be fully equipped with driving, operating and analyzing control panels, ergonomically fitted to enable effective operation in both directions for long working periods. The driver desk and main operating equipment and control panels shall comply with UIC 651 paragraph 4.

8.5 Cabin Windows

The cabin windows and windows accessories such as wipers washers and sunshades shall comply with UIC 651 paragraph 2.7.

8.6 Noise Level

The noise level in the cabin shall meet the requirements of UIC 651 paragraph 2.10.

8.7 Cabin Amenities

The cabin shall be equipped with a micro-wave heating appliance and a small refrigerator, as recommended in UIC 651 paragraph 2.11.2.

8.8 Control Panel
8.8.1 The driver control panels in both driver posts shall include at least following instruments:

8.8.1.1 Tachometer;
8.8.1.2 Hour meter;
8.8.1.3 Ammeter;
8.8.1.4 Fuel control indicator;
8.8.1.5 Engine coolant temperature indicator;
8.8.1.6 Coolant level indicator;
8.8.1.7 Transmission oil temperature indicator;
8.8.1.8 Transmission oil pressure gauge;
8.8.1.9 Engine oil temperature indicator;
8.8.1.10 Engine stop push-button;
8.8.1.11 Horn push-button;
8.8.1.12 Battery charge indicator;
8.8.1.13 Portable lamp plug;
8.8.1.14 Outside lighting switches;
8.8.1.15 Inside lighting switches;
8.8.1.16 “DEAD MAN” pedal;
8.8.1.17 Electrical sockets 24 VDC and 220 VAC;
8.8.1.18 INDUSI control panel on both traveling direction.

8.8.2 All Panel labels shall be in English, except some that shall be dual language English/Hebrew. Translation will be provided by ISR. Hebrew letter characters will be according to ISO/IEC 8859-8:1999.

9 Safety Systems and Equipment

The TMVM shall be equipped with following safety systems:

9.1 Automatic Vigilance Device

An Automatic Vigilance Device (Dead-Man Device) shall be provided and shall comply with UIC 641 and UIC 651 paragraph 4.3.2.6. Activation shall be by pedal.

9.2 INDUSI System

An INDUSI system shall be installed in TMVM that shall fully comply with the system used by ISR, namely, Alcatel 6411 AlTrac system, Inductive Automatic Train Protection (INDUSI I60R) produced by ALCATEL Germany (See Attachment C). The magnets of the INDUSI system shall be installed on the left hand side of the vehicle, and shall not interrupt the inspection system on the TMVM and the axle counter system on the track.

9.3 Safety Equipment
The following safety equipment shall be installed on the TMVM:

9.3.1 2 Rotating beacons (one to each direction).
9.3.2 2 Electro-pneumatic warning horns (one to each direction).
9.3.3 3 Fire extinguishers containing dry powder (one in each driver cabin and one near the measurement system rack).
9.3.4 Automatic fire extinguishing based on FM-200 gas in the measurement system rack.
9.3.5 Fire alarm system with Temperature and smoke detectors
9.3.6 4 Horn push buttons on each corner of the vehicle (outside the cabin).
9.3.7 4 Engine stop push buttons on each corner of the vehicle (outside the cabin).

10 Lighting Systems

10.1 External lighting
External lights shall be according to UIC 534. Headlamps shall be arranged according to paragraph 2.7 of UIC 534.

10.2 Internal Lighting
Internal Lighting in the cabins shall provide effective working conditions during night operation.

11 Faults Monitoring System
The vehicle shall be equipped with a fault monitoring system.

The system shall diagnose and monitor faults that may occur in each one of the following vehicle systems: Drive line, electric; hydraulic; pneumatic.

The faults diagnosing and monitoring shall be displayed by computerized system which hardware and software shall be supplied as an integral part of the TMVM.

12 Documentation
The following technical data shall be provided with the vehicle:

12.1 Operation and Maintenance Manuals and Spare Parts Catalogue for the following systems:
- Vehicle;
- Engine system;
- Transmission system;
- Drive Axles;
- Air-conditioning system;
- Measuring, Analyzing and Recording System;
- Electrical system.
Four hard copies and two magnetic copies (DVD) shall be provided of all the listed data. All documents shall be in English.

12.2  Manuals Content

The operation and maintenance manuals shall include at least the following chapters:

12.2.1 Safety precautions;
12.2.2 Systems description;
12.2.3 Operation instructions.

That shall include: Pre-operation checks, Start-Up procedure, Operating procedures (operation limitations should be stated clearly and in bold letters), Shut-down procedure, Emergency procedures, Troubleshooting.

12.2.4 Preventive maintenance instructions;
12.2.5 Calibration and adjustments instructions;
12.2.6 Components replacement procedures;
12.2.7 The spare parts catalogues shall include illustrated parts breakdown (sub-contractor items included) with a set of section drawings or axonometric/"blow-up" drawings and a list for each one of the drawings including the following data elements:

- Item number on the drawing;
- Item name;
- Manufacturer’s part number;
- Sub-contractor’s part number (for sub-contractors parts);
- Sub-contractor name;
- Quantity per assembly.

All the documentation mentioned above shall be comprehensive to the extent that in the event of a failure of a working part of any manufactured component, maintenance personnel shall be able to refer the parts data books to obtain the model number of the component and order the required part without being compelled to dismantle the component.

This documentation should be utilized in training inexperienced personnel for operation and maintenance and should be based on the operation, maintenance and illustrated spare parts catalogue manuals specification.

12.2.8 The technical documentation shall be arranged as an interactive electronic technical manual (IETM), namely a high-quality database product. This IETM shall allow for multiple methods of accessing the data using full-text searching tool, or access to the required paragraphs or drawings using the table of contents hyperlinks, as well as for interactive cross-reference within each publication, and between different but related publications (e.g. cross-references between Maintenance Manual and
Parts Catalogue). The IETM user interface shall be in English. The IETM should support the following features (non-comprehensive list):

- End-user access control;
- Annotations and bookmarks;
- Easy navigation between documents titles and sub-titles;
- Combined Boolean full-text search;
- Nested querying - up to 4 nesting search levels;
- Compound documents viewer (text, tables, raster/vector images, audio, video, etc.);
- Multi-target hyperlinks;
- External executable links;
- Exporting images in their native format; exporting text.

13 Production Process

13.1 Quality Control

Together with the proposal the bidder shall submit to ISR a copy of its quality control manual. The following procedures must be included in the manual:

13.1.1 Tests Plan

Listing all the tests that will be performed by the supplier on the vehicle during the production, including test at major sub-contractors. Submit a sample test plan. The actual test plan shall be submitted 15 days after contract award.

13.1.2 Final Test Details

The final test of the vehicle shall be conducted following the guidelines of EN 50215:2002 “Testing of Rolling Stock after completion of construction and before entry into service”.

The final test of the measurement system shall be conducted according to EN 13848-2 Annex C: "Description of field tests: values to be respected".

Submit a sample final test plan. The actual test plan will be submitted one month before commencement of the test.

13.1.3 Submittals Procedure

Before releasing parts for production, or ordering components from sub-contractors, the shop drawings or the sub-contractors technical specifications shall be submitted for ISR’s prior approval.

13.1.4 Deficiencies Tracking Procedures

The quality control manual will show the procedure how the supplier tracks and closes deficiencies that were discovered during the manufacturing process. The deficiencies will include among other parameters at least the following:
Deficiency Description;
Remedial Plan.

13.2 Manufacturing Schedule
Within 21 days after contract award the supplier shall present his manufacturing schedule. The schedule shall show the timing and duration for the following tasks that will take place with the participation of ISR personnel.

13.2.1 Design Review
13.2.2 Final vehicle and measurement systems tests

14 Handing-over Procedure
The handing-over procedure shall include the following tasks:

14.1 At the manufacturing plant:
14.1.1 Visual check of the vehicle and its systems for compliance with the specifications drawings and the submittals.
14.1.2 Checking of all test reports which were issued during the production for compliance with the test plan.
14.1.3 Running test of the vehicle and its systems including the measurement system.
   A representative of the domestic railway authority will participate in this test and will certify that all propulsion, driving, braking, towing; visibility; vigilance and the INDUSI systems meet the EN and the UIC codes and are functioning properly.
   The work of the representative will be for the account of the supplier.
14.1.4 Checking of all the hard copies of the operation and maintenance manuals, parts breakdown and drawings sets for compliance with the specifications requirements,
   Checking of all the Interactive Electronic Technical Manual (IETM) of the operation and maintenance manuals, parts breakdown and drawings sets for compliance with the specifications requirements and its hyperlinks and search capabilities.
14.1.5 After approval of all the tests the vehicle shall be sealed, protected and prepared by the supplier for the sea transportation.

14.2 At destination:
Tasks to be performed by the supplier:
14.2.1 Removal and cleaning the vehicle packaging and inhibiting materials.
14.2.2 Functional tests of all vehicle systems.
14.2.3 Operators and maintenance personnel training.
## Attachment A

### Climate and Environmental Conditions

Climate and Environmental Conditions

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<thead>
<tr>
<th>Max. Ambient temp.</th>
<th>+50 °C (shade)</th>
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<tbody>
<tr>
<td>Min Ambient temp.</td>
<td>-5 °C</td>
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<tr>
<td>Relative humidity</td>
<td>10% to 90%</td>
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<tr>
<td>Altitude</td>
<td>- 400 m to +800 m</td>
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<tr>
<td>Sunny hours per year</td>
<td>3300</td>
</tr>
<tr>
<td>UV Radiation MJ/m² per year</td>
<td>360-600</td>
</tr>
<tr>
<td>Rainfall mm/year</td>
<td>400-800</td>
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</tbody>
</table>

Dust Conditions in the atmosphere

(Microgram per m³ atmosphere)

<table>
<thead>
<tr>
<th></th>
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<th>Maximum Daily Value</th>
<th>Average</th>
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<tr>
<td>NOx</td>
<td>1064</td>
<td>560</td>
<td>71</td>
</tr>
<tr>
<td>SO2</td>
<td>780</td>
<td>260</td>
<td>21</td>
</tr>
<tr>
<td>O3</td>
<td>312</td>
<td>143</td>
<td>84</td>
</tr>
<tr>
<td>Suspended Dust</td>
<td>350</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Suspended **Particulate Matter (SPM)**

**Particle size to 0.5-1 micron**

Sea Salt Concentrations in the Atmosphere

(Micrograms per m³ atmosphere)

<table>
<thead>
<tr>
<th>Salt Element</th>
<th>Season</th>
<th>Season</th>
<th>Season</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Dry</td>
<td>Wet</td>
<td>Dry</td>
</tr>
<tr>
<td>Sea Air at Coast Line</td>
<td>7.3</td>
<td>16.0</td>
<td>12.0</td>
</tr>
<tr>
<td>600 m from Shore</td>
<td>3.1</td>
<td>4.8</td>
<td>4.2</td>
</tr>
<tr>
<td>6000 m from Shore</td>
<td>1.1</td>
<td>1.4</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Attachment B

Loading Gauge
The Alcatel 6411 AlTrac is an inductive automatic train protection system for enhanced safety.

**Description**

The Alcatel 6411 AlTrac is an inductive automatic train protection system for enhanced safety. Under normal conditions the Alcatel 6411 AlTrac does not influence the driver's control. It activates the automatic application of the train brakes if the driver responds incorrectly or not at all to stop signals or warning signals.

**Main Functions**

The system has been divided into two main components. The trackside devices and the on-board equipment in the locomotive. The electronic components of the Alcatel 6411 AlTrac have greatly improved the operational safety. The on-board equipment makes the implementation of semicontinuous monitoring possible. The trackside equipment of the Alcatel 6411 AlTrac comprises passive track magnets and devices for the adaptation to the fixed line side signals. The track magnets are mounted at the side of the rail and are direction dependent. Contacts operated by the signals set the magnets to the appropriate frequency if the signal aspect is restricted. The on-board equipment is constructed in a very compact manner. The components consist of a central processing unit, the peripherals and the operating and display elements.
The central processing unit consists of the analogue unit which generates frequencies, detects inductive coupling and has interfaces with the computer port, the digital unit which contains the central microprocessor with integrated train data I/O board and finally the data storage unit which stores all relevant operational data.

The main feature is the compact design of the central processing unit.

The periphery is composed of the Alcatel 6411 ATTrac vehicle magnets and the brake actuator as an interface to the pneumatic brakes. A speed indicator determines the actual speed and the distance traveled. The software of the Alcatel 6411 ATTrac consists of a program packet for the computer and a packet for the data storage cassette which is driven by a separate computer.

The program package contains sections for the train data input and display, the operation program, the programs for detecting faults and programs for continuous data exchange with the data storage unit. The operation program monitors the speed of the train.

The Alcatel 6411 ATTrac automatically detects faults in the central processing unit and the peripherals. The driver is informed by a yellow indicator lamp and an alarm that a fault has occurred. At the same time a numbered fault message is transferred to the data storage unit. The PC based test device can then read out the stored fault number, test all Alcatel 6411 ATTrac functions automatically or via a keyboard and even simulate and test interfaces. Maintenance personnel can enter specific data into the computer using the test device for testing functionality.

A Special evaluation software package can be used to read out the data stored in the data storage unit.

The software runs on a standard PC. Depending on requirements the data can be either displayed, printed out or transferred to other data media.

**Essential Benefits**

- Compact and cost effective
- Operates with existing trackside equipment
- Extended display and operation elements
- Implements speed monitoring
- Uses commercially available computers
- Maintenance friendly through fault detection
- Improved information through the extended diagnosis and evaluation facilities.